CLAIMS

What is claimed is:

1. A method of transmitting data, comprising:

initiating transfer of a large data file containing a plurality of segments over a network by transmitting one or more segments of the plurality of segments utilizing a first set of M concurrent data streams, wherein M is one or more, followed by transmitting one or more segments of the plurality of segments utilizing a second set of N concurrent data streams, wherein N > M+1;

during transmission utilizing the first set of M concurrent data streams, determining individual transmission bandwidths for each concurrent data stream of the first set of M concurrent data streams and a first aggregate transmission bandwidth for the first set of M concurrent data streams;

during transmission utilizing the second set of N concurrent data streams, determining individual transmission bandwidths for each concurrent data stream of the second set of N concurrent data streams and a second aggregate transmission bandwidth for the second set of N concurrent data streams;

comparing the first aggregate transmission bandwidth to the second aggregate transmission bandwidth; and

responsive to a determination that the second aggregate transmission bandwidth is greater than the first aggregate transmission bandwidth by a first predetermined threshold, initiating a third set of Z concurrent data streams to transfer a portion of the large data file, wherein Z >N.

2. The method of claim 1, further comprising the step of:

responsive to a determination that the second aggregate transmission bandwidth is greater than the first aggregate transmission bandwidth by less than a second predetermined threshold, initiating the third set of Z concurrent data streams to transfer a portion of the large data file, wherein Z<N.

3. The method of claim 1, wherein Z is selected from a predetermined schedule of numbers that are separated by a relative ratio of greater than 120%.

4. The method of claim 1, wherein the step of determining individual transmission bandwidths for each concurrent data stream of the first and second set of concurrent data streams and the aggregate transmission bandwidths for the first and second set of concurrent data streams further comprises:

computing the individual transmission bandwidths from byte counts and clock times; and

computing the aggregate transmission bandwidth by summing the individual transmission bandwidths.

5. The method of claim 1, further comprising:

during continuous transfer of the large data file, periodically determining an aggregate transmission bandwidth for a current set of concurrent data streams transferring a portion of the large data file;

comparing a latest aggregate transmission bandwidth with a previous aggregate transmission bandwidth; and

responsive to a determination that the latest aggregate transmission bandwidth is different from the previous aggregate transmission bandwidth by a third predetermined

threshold, initiating a new set of concurrent data streams to transfer a portion of the large data file.

6. The method of claim 5, wherein the aggregate transmission bandwidth is a weighted average of all measurements of aggregate transmission bandwidth for the current set of concurrent data streams, with more recent measurements being given greater weight.

7. The method of claim 1, further comprising:

(a) determining whether the individual transmission bandwidths for an active set of concurrent data streams are close to a backbone limit;

(b) determining whether an aggregate transmission bandwidth for the active set of concurrent data streams is greater than an aggregate transmission bandwidth for a previous set of concurrent data streams by the first predetermined threshold; and

(c) responsive to an affirmative determination in steps (a) and (b), initiating a new set of concurrent data streams to transfer a portion of the large data file.

8. The method of claim 7, further comprising:

determining a specified maximum data stream count from either a system originating the large data file or a system receiving the large data file; and

repeating steps (a) through (c) until either the aggregate transmission bandwidth for the active set of concurrent data streams is not substantially greater than the aggregate bandwidth for all of the prior number of active data streams or the maximum data stream count is reached.

9. The method of claim 8, wherein the maximum data stream count is reduced by a system receiving the active set of concurrent data streams responsive to the aggregate transmission bandwidth for the active set of concurrent data streams.

10. The method of claim 1, further comprising the step of:

responsive to a determination that the second aggregate transmission bandwidth is approximately equal to the first aggregate transmission bandwidth within a threshold band, initiating the third set of Z concurrent data streams to transfer a portion of the large data file, wherein Z=N.

11. A system for transmitting data, comprising:

an originating system;

a receiving system;

a TCP/IP network coupling the originating system and the receiving system;

a first set of M concurrent data streams between the originating system and the receiving system on the network, each transmitting one or more segments of a plurality of segments of a large data file, wherein M is one or more, followed by transmitting one or more segments of the plurality of segments utilizing a second set of N concurrent data streams, wherein $N > M+1$;

logic within either the originating system or the receiving system for, during transmission utilizing the first set of M concurrent data streams, determining individual transmission bandwidths for each concurrent data stream of the first set of M concurrent data streams and a first aggregate transmission bandwidth for the first set of M concurrent data streams;

logic within either the originating system or the receiving system for, during transmission utilizing the second set of N concurrent data streams, determining individual transmission bandwidths for each concurrent data stream of the second set of N concurrent data streams and a second aggregate transmission bandwidth for the second set of N concurrent data streams;

logic within either the originating system or the receiving system for comparing the first aggregate transmission bandwidth to the second aggregate transmission bandwidth; and

logic within either the originating system or the receiving system responsive to a determination that the second aggregate transmission bandwidth is greater than the first aggregate transmission bandwidth by a first predetermined threshold by initiating a third set of Z concurrent data streams to transfer a portion of the large data file, wherein $Z > N$.

12. The system of claim 11, wherein Z is selected from a predetermined schedule of numbers that are separated by a relative ratio of greater than 120%.

13. The system of claim 11, further comprising:

logic within either the originating system or the receiving system for, during continuous transfer of the large data file, periodically determining an aggregate transmission bandwidth for a current set of concurrent data streams transferring a portion of the large data file;

logic within either the originating system or the receiving system for comparing a latest aggregate transmission bandwidth with a previous aggregate transmission bandwidth; and

logic within either the originating system or the receiving system responsive to a determination that the latest aggregate transmission bandwidth is different from the previous aggregate transmission bandwidth by a third predetermined threshold by initiating a new set of concurrent data streams to transfer a portion of the large data file.

14. The system of claim 13, wherein the aggregate transmission bandwidth is a weighted average of all measurements of aggregate transmission bandwidth for the current set of concurrent data streams, with more recent measurements being given greater weight.

15. The system of claim 11, further comprising logic within either the originating system or the receiving system for:

(a) determining whether the individual transmission bandwidths for an active set of concurrent data streams are close to a backbone limit;

(b) determining whether an aggregate transmission bandwidth for the active set of concurrent data streams is greater than an aggregate transmission bandwidth for a previous set of concurrent data streams by the first predetermined threshold; and

(c) responsive to an affirmative determination in steps (a) and (b), initiating a new set of concurrent data streams to transfer a portion of the large data file.

16. The system of claim 15, further comprising logic within either the originating system or the receiving system for:

determining a specified maximum data stream count from either a system originating the large data file or a system receiving the large data file; and

repeating steps (a) through (c) until either the aggregate transmission bandwidth for the active set of concurrent data streams is not substantially greater than the aggregate bandwidth for all of the prior number of active data streams or the maximum data stream count is reached.

17. The system of claim 16, wherein the maximum data stream count is reduced by a system receiving the active set of concurrent data streams responsive to the aggregate transmission bandwidth for the active set of concurrent data streams.

18. The system of claim 11, further comprising logic within either the originating system or the receiving system responsive to a determination that the second aggregate transmission bandwidth is approximately equal to the first aggregate transmission bandwidth within a threshold band, initiating the third set of Z concurrent data streams to transfer a portion of the large data file, wherein Z=N.

19. An article of manufacture for use in transmitting data, the article of manufacture comprising computer readable storage media including program logic embedded therein that causes control circuitry to perform the steps of:

initiating transfer of a large data file containing a plurality of segments over a network by transmitting one or more segments of the plurality of segments utilizing a first set of M concurrent data streams, wherein M is one or more, followed by transmitting one or more segments of the plurality of segments utilizing a second set of N concurrent data streams, wherein N > M+1;

during transmission utilizing the first set of M concurrent data streams, determining individual transmission bandwidths for each concurrent data stream of the first set of M concurrent data streams and a first aggregate transmission bandwidth for the first set of M concurrent data streams;

during transmission utilizing the second set of N concurrent data streams, determining individual transmission bandwidths for each concurrent data stream of the second set of N concurrent data streams and a second aggregate transmission bandwidth for the second set of N concurrent data streams;

comparing the first aggregate transmission bandwidth to the second aggregate transmission bandwidth; and

responsive to a determination that the second aggregate transmission bandwidth is greater than the first aggregate transmission bandwidth by a first predetermined threshold, initiating a third set of Z concurrent data streams to transfer a portion of the large data file, wherein Z >N.

20. The article of manufacture according to Claim 19, further comprising the step of:

responsive to a determination that the second aggregate transmission bandwidth is greater than the first aggregate transmission bandwidth by less than a second

predetermined threshold, initiating the third set of Z concurrent data streams to transfer a portion of the large data file, wherein Z<N.

21. The article of manufacture according to Claim 19, further comprising the step of:

responsive to a determination that the second aggregate transmission bandwidth is approximately equal to the first aggregate transmission bandwidth within a threshold band, initiating the third set of Z concurrent data streams to transfer a portion of the large data file, wherein Z=N.

22. The article of manufacture according to Claim 19, wherein Z is selected from a predetermined schedule of numbers that are separated by a relative ratio of greater than 120%.

23. The article of manufacture according to Claim 19, wherein the step of determining individual transmission bandwidths for each concurrent data stream of the first and second set of concurrent data streams and the aggregate transmission bandwidths for the first and second set of concurrent data streams further comprises:

computing the individual transmission bandwidths from byte counts and clock times; and

computing the aggregate transmission bandwidth by summing the individual transmission bandwidths.

24. The article of manufacture according to Claim 19, the steps further comprising:

during continuous transfer of the large data file, periodically determining an aggregate transmission bandwidth for a current set of concurrent data streams transferring a portion of the large data file;

comparing a latest aggregate transmission bandwidth with a previous aggregate transmission bandwidth; and

responsive to a determination that the latest aggregate transmission bandwidth is different from the previous aggregate transmission bandwidth by a third predetermined threshold, initiating a new set of concurrent data streams to transfer a portion of the large data file.

25. The article of manufacture according to Claim 24, wherein the aggregate transmission bandwidth is a weighted average of all measurements of aggregate transmission bandwidth for the current set of concurrent data streams, with more recent measurements being given greater weight.

26. The article of manufacture according to Claim 19, the steps further comprising:

(a) determining whether the individual transmission bandwidths for an active set of concurrent data streams are close to a backbone limit;

(b) determining whether an aggregate transmission bandwidth for the active set of concurrent data streams is greater than an aggregate transmission bandwidth for a previous set of concurrent data streams by the first predetermined threshold; and

(c) responsive to an affirmative determination in steps (a) and (b), initiating a new set of concurrent data streams to transfer a portion of the large data file.

27. The article of manufacture according to Claim 26, the steps further comprising:

determining a specified maximum data stream count from either a system originating the large data file or a system receiving the large data file; and

repeating steps (a) through (c) until either the aggregate transmission bandwidth for the active set of concurrent data streams is not substantially greater than the aggregate

bandwidth for all of the prior number of active data streams or the maximum data stream count is reached.